

ELECTRO MECHANICAL BRAKE, CONTROL DEVICE
AND CONTROL METHODS

BACKGROUND OF THE INVENTION

Field of the Invention

This invention relates to an electro-mechanical brake device for an automobile, and more particularly to a parking mechanism and a control method of maintaining a braking force even when a power supply is turned off.

Description of the Related Art

JP-A-2001-163198 discloses a vehicle control device in which a braking force maintaining instruction is outputted to a braking device when an automatic stall condition of an engine is satisfied.

In the patent document mentioned above, the braking force maintaining instruction output and the braking force releasing control are carried out based on an automatic engine stop condition, an automatic engine stop release condition and restart condition of the engine. However, any consideration has not been paid to the fact that the braking force is to be maintained at the time when the vehicle is parked on a way of a slope road. This causes a problem that the braking force maintaining control is not performed in case that the vehicle is suddenly stopped by turning off an ignition key switch on a way of the slope road.

In that case, there is a possibility that the vehicle is ready to move down along the slope road.

SUMMARY OF THE INVENTION

It is an object of this invention to provide
5 an electro-mechanical braking device which outputs a
braking force to maintain the vehicle to be stopped
securely under the environments that the vehicle is
parked on a way of the sloping road in case the vehicle
is parked by turning off the ignition key switch, or in
10 case power is not supplied to the electro-mechanical
brake or a control signal is not applied thereto.

In order to solve the problem as mentioned
above, this invention provides a control device for
controlling a motor drive brake including a parking
15 brake mechanism for maintaining the braking force in
case power is not supplied or a control signal is not
applied. The control device detects whether a braking
pedal is stepped on or a brake operation signal is
present and also detects that the ignition key switch
20 or the power supply switch of the vehicle is turned
off, and further controls the parking brake mechanism
so that the braking force may be maintained on the
basis of these detection results.

Also, in order to maintain the braking force
25 of the parking brake mechanism, a motor for generating
the braking force is driven on the basis of the
detection results describe above, and the parking brake

mechanism for maintaining the braking force is operated at the time when the braking force reaches a predetermined value.

Other objects, features and advantages of the invention will become apparent from the following description of the embodiments of the invention taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a diagram showing the constitution of this invention.

Fig. 2 is an explanatory diagram of an electro-mechanical braking device provided with a parking brake mechanism according to this invention.

Fig. 3 is an operation logic circuit diagram of the parking brake mechanism of this invention.

Fig. 4 is a release logic circuit diagram of the parking brake mechanism of this invention.

Fig. 5 is a flowchart of this invention.

Fig. 6 is another flowchart of this invention.

DESCRIPTION OF THE INVENTION

This invention provides the electro-mechanical parking brake mechanism for maintaining the braking force even when the power supply switch is turned off. In this invention, the parking brake mechanism is activated (the braking force is

maintained) when an ignition key switch or the power supply switch of the vehicle is turned off under the condition that the braking pedal is stepped on or the braking operation signal is present.

5 Also, when the power supply switch (the ignition key switch) of the vehicle is turned off with the braking pedal being stepped on, the motor for generating the braking force is driven, and the parking brake mechanism for maintaining the braking force is
10 activated at the time when the braking force reaches a predetermined value.

 According to this invention, even when the power supply to the motor for generating the braking force is turned off, the braking force is maintained by
15 the parking brake mechanism, so that the vehicle may be parked in case the vehicle is stopped on a way of the slope road.

 Hereinafter, referring to the drawings, one embodiment of this invention is described in detail.
20 However, this invention is not limited to the embodiment described below.

 Fig. 1 is a diagram showing a system constitution of this invention. A braking controller 1 receives input signals such as a signal from a braking
25 stroke sensor 3 for sensing a stroke amount of a braking pedal 2 by a driver, a signal from a parking brake switch 4 for turning on or off an activation of the parking brake mechanism, a signal from a key switch

5 or a power supply switch (or an ignition key switch) of the vehicle, a signal from a vehicle speed sensor 6 for sensing a speed of the vehicle, a signal from an engine speed sensor 7 for sensing an engine speed, a
5 signal from a parking/neutral switch 8 which indicates whether a gear is connected or not connected (ON indicates a non-connection state and OFF indicates a connection state), a signal from an acceleration stroke sensor 9 for sensing a stroke amount of an acceleration
10 pedal by the driver, and a signal from a starter switch 10 which indicates whether or not an starter of the engine is started up.

On the basis of the input signals described above, the braking controller 1 outputs a control
15 signal for obtaining a necessary braking force to an electro-mechanical brake (EMB) 22. The input signals inputted to the braking controller as described above, the contents processed in the controller and the output signals outputted from the controller are not limited
20 to the contents described above, but can include all of contents necessary for controlling the electro-mechanical brake. Also, the brake controller as described above can be incorporated into another control unit such as an engine control unit.

25 Fig. 2 is an explanatory diagram showing the electro-mechanical brake (EMB) 22 provided with a parking brake mechanism. The electro-mechanical brake (EMB) 22 includes a motor 221, a screw mechanism unit

222 for converting a rotational movement of the motor into a reciprocal movement of the screw, a lock mechanism unit 225 for mechanically locking the reciprocal movement of the screw of the screw mechanism unit, an electro-mechanical parking brake mechanism unit 21 for switching between locking (fixing)/unlocking (loosing) of the lock mechanism unit, a braking pad 224 for generating a predetermined braking force by pressing the screw mechanism unit against a brake disc 23, and a braking force sensor 223 for detecting an actual braking force.

The electro-mechanical parking brake mechanism unit 21 includes a motor 211 such as a small sized motor and a screw mechanism unit 212 so that the screw mechanism of the electro-mechanical brake may be fixed or released by a driving force of the motor 211. According to such configuration, the electro-mechanical parking brake mechanism unit 21 and/or the lock mechanism unit 225 may lock the screw mechanism unit 222 under the condition that the braking pad 224 is being pressed against the brake disc 23 until a predetermined braking force is obtained from a rotational force of the motor 221. As a result, the braking force is maintained even when the rotational force (electric current value) of the motor 221 is made equal to zero (0).

The mechanism, configuration, structure and operation of the electro-mechanical brake and those of

the parking brake merely indicate one example of this invention, and it is also possible to employ a mechanism using only the rotational movement of the motor, and another mechanism other than the screw
5 mechanism in order to convert the rotational movement into the reciprocal movement.

Fig. 3 shows one example of a logic circuit diagram for activating the electro-mechanical parking brake mechanism by the braking controller of this
10 invention. The electro-mechanical parking brake mechanism is activated to maintain the braking force under the condition that the braking pedal 2 is in on state (stepped on), and the key switch 5 (power supply switch of the vehicle) is turned off, and a speed of
15 the vehicle is equal to 0 km/h (parked) or the engine speed is equal to 0 rpm (stopped), and the parking/neutral switch is turned on (the gear is not connected), and the acceleration stroke is equal to 0 mm (the acceleration pedal is not stepped on), and the
20 starter switch is turned off (the starter is not started up).

In case the driver turns on the parking brake switch 4 regardless of these conditions indicated above, the electro-mechanical parking brake mechanism
25 is activated to maintain the braking force.

The conditions as shown in Fig. 3 become the signals from each of the sensors (for example, 6, 7, 8, 9, and 10 in the Figure). The contents of these

conditions are adopted in order to detect that the vehicle is completely parked and the driver has no intention of starting the vehicle.

In case, regardless of these conditions
5 indicated above, the key switch is turned off with the braking pedal being stepped on, it is determined that the driver basically has an intention of stopping the vehicle. Accordingly, the electro-mechanical parking brake mechanism may be activated to maintain the
10 braking force. The value of maintaining the braking force is selected from either one of a value corresponding to a stroke amount or stroke force of the braking pedal 2, a value obtained from correcting the stroking value or a predetermined value.

15 Fig. 4 shows one example of the logic circuit diagram for cancelling the braking force of the electro-mechanical parking brake mechanism through the braking controller of this invention. The electro-mechanical parking brake mechanism is released to
20 maintain the braking force equal to zero, namely, the braking disc 23 is loosened under the conditions that the key switch 5 (power supply switch of the vehicle) is turned on with the braking pedal 2 being off state (not stepped on), and, when the engine speed is equal
25 to, for example, 500 rpm (the starting of the engine is completed), the parking/neutral switch is turned off (the gear is connected) or the acceleration stroke is more than 0 mm (the acceleration pedal is stepped on)

or the starter switch is turned off (the starter is not started up).

In case, regardless of the conditions indicated above, the driver turns off the parking
5 brake switch 4, the motor 221 and the screw mechanism unit 222 are driven to release the electro-mechanical parking brake mechanism so that the braking force is maintained to be zero to loose the brake disc 23.

The engine speed more than 500 rpm as shown
10 in Fig. 4 indicates the detection or confirmation of the fact that the starting of the engine is completed. Also, the parking/neutral switch being turned off (the gear being connected) and the acceleration stroke being more than 0 mm (the acceleration pedal being stepped
15 on) indicate the detection or confirmation of the fact that the driver has intention of starting the vehicle. In case the vehicle such as an electric-powered vehicle or a hybrid electric vehicle is started by the motor, the engine speed being more than 500 rpm is not
20 required owing to no provision of the engine.

Figs. 5 and 6 show flowcharts of this invention, respectively. The brake controller performs processes of the flowcharts based on the input signals applied thereto. A step 90 performs an input
25 processing for various kinds of signals. A step 100, for example, determines whether the conditions shown in Fig. 3 are satisfied or not. If satisfied (YES), a step 101 performs the processing of activating the

electro-mechanical parking brake mechanism to maintain the braking force, and then terminates the processing. If not satisfied (NO), a step 102 determines whether the conditions as shown in Fig. 4 are satisfied or not.

5 If satisfied (YES), the electro-mechanical parking brake mechanism is released to maintain the braking force to be zero. Namely, in this embodiment, the motor 221 and the screw mechanism unit 222 are driven to loose the braking disc 23, and then the processing
10 is terminated.

In the step 102 performing the processing of determining whether the conditions are satisfied or not, if not satisfied (NO), the processing goes to a step 200 shown in Fig. 6.

15 The step 200 shown in Fig. 6 determines whether the electro-mechanical brake (EMB) 22 is unlocked or not (the braking force is maintained to be zero). In this embodiment, the processing is determined depending on the fact that an activation
20 position of the small-sized motor 211 of the electro-mechanical parking brake mechanism 21 corresponds to either one of the fixing or loosening states of the screw mechanism of the electro-mechanical brake. If YES, a step 201 determines whether the conditions for a normal
25 electro-mechanical brake control are satisfied or not. If NO, the electro-mechanical brake is locked, and then the processing is terminated.

If YES in the step 201, a step 202 performs

the processing of controlling an electro-mechanical
braking motor 221 so that the braking force may
correspond to a braking stroke amount (stroking amount
of the braking pedal). If NO, a step 203 performs the
5 processing of controlling the motor 221 to maintain the
braking force of the electro-mechanical brake to be
zero, and then the processing is terminated.

As described above, according to this
invention, the parking-brake mechanism is provided to
10 maintain the braking force even when the power supply
switch is turned off. When the power supply switch
(ignition key switch) of the vehicle is turned off with
the braking pedal being stepped on or the braking
operation signal being present, the parking brake
15 mechanism is activated (the braking force is
maintained). In case the power supply switch (ignition
key switch) of the vehicle is turned off with the
braking pedal being stepped on, the motor for
generating the braking force is driven to activate the
20 braking force maintaining parking brake mechanism at
the time when the braking force reaches a predetermined
value. Even when the power supply to the motor for
generating the braking force is turned off, the braking
force is maintained by the parking brake mechanism so
25 that the vehicle may be securely stopped when the
vehicle is parked on a way of the slope road.

According to this invention, when the power
supply or the control signal to the motor for

generating the braking force is turned off, a logic operation of the input signals is performed to determine whether the braking force is maintained by the parking brake mechanism or not. If it is necessity
5 to maintain the braking force, then it is controlled that the braking force is provided to the electro-mechanical brake. Accordingly, the vehicle is securely stopped without movement on a way of the slope road with the braking force being maintained.